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# Proposed solutions for marine debris in the Windward Islands- perspectives from key policy makers and policy influencers

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With the rise of regionalization and globalized approaches to dealing with the associated sources and impacts of marine debris, it is often a challenge to properly capture the unique context and special needs of small island developing states (SIDS) worldwide. In the SIDS context, locals' perspectives should have a voice in scientific research, as well as in devising potential solutions, at all and different scales. With the view to tailor solutions for the prevention, reduction and mitigation of marine debris, this research explores the professional opinion of local knowledge holders including policy makers from government organizations (GOs) and key policy influencers in non-governmental organizations (NGOs) in the five English-Speaking Windward Islands of the Eastern Caribbean. To achieve that objective, surveys were conducted with these two groups in Barbados, Dominica, Grenada, St. Lucia and St. Vincent and the Grenadines. On the causes of the debris problem, the survey revealed that the lack of a proper waste management systems on islands, recycling limitations and inappropriate disposal behaviors of the population are generally thought to be the main contributory factors to the accelerating problem of marine debris. Further, phenomena such as *Sargassum* influxes, sea level rise and extreme weather events exacerbate the problem including most especially tropical storms and hurricanes. On the recommended solutions, over eighty percent of the participants identified monitoring and policing services as a main constraint that prohibits sound coastal and marine litter handling. Ninety-five percent identified establishing feasible recycling systems and sixty-seven percent identified changing social behaviors (including a combination of product and consumer literacy, disposal habits, compliance with laws and regulations) as national priorities for enabling on-the-ground actions for better coastal and marine litter prevention and reduction going forward. These findings reinforce recently published work which indicates the need for effective solid waste management systems in the Eastern Caribbean for cleaner and healthier oceans. An additional recommendation was proposed to address a major source of the marine litter problem- upstream producers. Furthermore, given the natural events component, this research proposes incorporating the Sendai Framework for disaster risk reduction in future proposed mitigation measures with a view to building the resilience of SIDS and local communities in combating the impacts of marine debris.

## KEYWORDS

marine debris, local perspectives, Windward Islands, landfill, sendai framework, solid waste

# 1 Introduction

Marine debris (also referred to as marine litter) is on the global agenda largely because the mismanagement of solid waste (particularly plastics) and its associated risks, threats and impacts continue to increase (MacLeod et al., 2021; Haarr et al., 2022). A Global Assessment of Marine Litter and Plastic Pollution, shows the gravity of the problem indicating that by 2040, volumes of marine plastic pollution will nearly triple, specifically adding 23-37 million metric tons of plastic waste into the ocean per year (Maes et al., 2021). It is well documented that marine litter and plastics reach even the most remote parts of the global oceans, such as small island developing states (SIDS) (Lachmann et al., 2017). The challenges and needs which SIDS face in their pursuit to prevent and reduce domestic and transboundary marine debris are certainly unparalleled to the rest of the world given their unique and particular vulnerabilities.

SIDS are often characterized by their lack of human resource capacity, serious financial and resource limitations, lack of management and adaptive capacities and economic vulnerability (Hadjimanolis, 1999; Kirton, 2013; Nurse et al., 2014; Field et al., 2014; Burt et al., 2022). Moreover, SIDS tend to encapsulate several other global sustainable development challenges (Connell, 2013; Kelman et al., 2015). Thus, global agendas to build resilience and to counteract marine debris are and should be very relevant for SIDS.

SIDS and their even smaller and remote dependencies are however a special case for sustainable development and could potentially offer insight into the practicality of localizing global initiatives. In the context of marine debris, how well SIDS' needs are reflected in global agendas are questionable. Unique island issues and needs tend to get lost in translation or generalised in national to international discussions and forums (Graham, 2022b). Also, in many instances, global changes and trends are recommended or even imposed on small islands without adequate support to address those challenges (Kelman et al., 2015; Graham, 2022b).

Marine debris in SIDS of the Wider Caribbean Region (WCR) has long been a crucial environmental problem (Corbin and Singh, 1993; Barnett, 1997; Singh and Xavier, 1997; Siung-Chang, 1997; Debrot et al., 1999; do Sul and Costa, 2007) and today is often grouped with climate change as an emerging issue with severe socio-economic and ecological implications (Kemper and Sayed, 2019; Lincoln et al., 2022). This research investigates the marine litter situation in a sub-group of WCR, the Windward Islands.

## 1.1 The Windward Islands' situation

The Windward Islands are located in the south of the Eastern Caribbean archipelago and include the islands of Dominica, Grenada, St. Lucia, St. Vincent and the Grenadines (SVG) as well as the easternmost island, Barbados (Humphrey et al., 1997; Matthews, 2018; National Trust for Historic Preservation, 2021). The term "windward" means that the islands are exposed to the northeast trade winds coming from the Atlantic Ocean. These islands present a unique situation for marine debris scientific studies for several reasons. First, there is a dearth of knowledge due to the relatively low number of published empirical research on marine debris issues

for the specific islands (Graham, 2022b), which can limit the scope for taking appropriate management measures. Second, most of their population, main cities and socio-economic activities are located on and near the coastline (World Bank, 2014; United Nations Environment Programme (UNEP), 2019) which often results in solid waste pollution in associated environments. This poses several grave threats to ocean and coastal economies (especially tourism and fisheries) which the same populations depend upon (Clayton et al., 2021; Graham, 2022b).

Third, their coastlines and associated activities are further threatened yearly by hurricanes and storm surges (Ferdinand, 2013) among other climatic hazards (Miranda et al., 2021). A fourth reason relates to geographical footprint of the Windward Islands which are not only challenged by dealing with the domestic generation of solid waste but are also affected by marine and land debris from other regions through ocean currents (de Scisciolo et al., 2016). According to a review by Graham (2022b), the internal generation of waste for the Windward Islands typically comes in the form of plastic waste produced by tourists and recreational activities, other inappropriate disposal behaviors e.g., littering and illegal dumping and derelict fishing gear. However, the Windward Islands are also affected by debris that comes from both the North Atlantic Gyre and its prevailing currents (World Bank, 2019), as well as debris that comes with the south equatorial currents above Venezuela, extending into the North Atlantic gyre (Hurley et al., 2019). Fifth, challenges arise from the modern and common issues associated with debris entrapped in *Sargassum* influx on beaches within the region (Graham, 2022a).

Lastly, there are several remote and smaller islands called the Grenadines, also known as Grenadine Islands, which fall within this sub-group of the region. These islands have an even higher dependence on coastal and marine resources and are likely impacted by marine debris. However, there is no scientific research that investigates this topic and area in detail. The Grenadines are thirty-five (35) small islands located between Grenada and St. Vincent (Giovas, 2016). Nine (9) of these islands contain permanent human settlements (The United Nations Educational, Scientific and Cultural Organization UNESCO, 2022). Although there exists an agreed international maritime boundary between Grenada and SVG (running east to west across the bank between Petit Martinique and Petit St. Vincent), the socio-economic linkages among all the Grenadine Islands are historically strong and continue to be active. According to the UNESCO (2022), fishing (subsistence and commercial), informal trade, tourism and island social life proceed with little attention to the boundary, which is poorly policed on a day-to-day basis. Undoubtedly, the dynamic nature of these factors can and do influence the scope for decision-making regarding how best to address transboundary issues, as well as the outcomes of marine debris management among the islands.

## 1.2 Relevance of local knowledge

An initial and crucial step in tackling several complex marine problems is gathering evidence and observations at the local level and integrating lessons learnt into discussion forums and policy proposals at higher levels (i.e. regional and then international) (Alexander et al.,

2019; Sheridan et al., 2020). This is in order to better achieve global goals. Transnational activism among SIDS, particularly of the global south, has in the past had ocean related issues and suggestions reach to the highest of global discussions and agendas which subsequently made positive local changes (Bueger and Wivel, 2018; Mead, 2021). Moreover, without local knowledge, science can find it difficult to influence policy and actual change (Nugroho et al., 2018).

From regulatory and public policy perspectives, it is widely recognized that regional cooperation provides an essential link between the global and national level of governance (Hettne and Söderbaum, 2006; Rochette et al., 2014; Mahon and Fanning, 2019). This therefore enables a level of co-responsibility and support required for implementing marine related policies that align with global objectives (Rochette et al., 2014; Mahon and Fanning, 2019). And if not align, then perhaps local and national input having positive influences on future regional and global plans and opportunities.

In the case of the Windward Islands, they are yet to develop policies which target marine debris and reflects the Wider Caribbean's 2014 Regional Action Plan for Marine Litter (RAPMaLi)<sup>1</sup> or the most recent 2021 Strategic Plan for Marine Litter Management in the Wider Caribbean Region Caribbean Node for Marine Litter<sup>2</sup>. Ideally local representation would have contributed to these regional plans, but a literature review by Graham (2022a) revealed that there's a possibility that not all pertinent issues at the local level were captured by the said Plan. Further, there are follow up questions, for instance, how can global entities propose better marine debris solutions that addresses the unique circumstances of SIDS, and are they able to simultaneously support *via* helping with the foundational capacities that can promote the growing demand for economies to be more circular in the process?

The answers likely remain unexplored in local-level knowledge and experiences. In WCR SIDS context, this level of knowledge can be gathered from policy makers and experts within Government Organisations (GOs) and from active non-governmental organizations (NGOs). These individuals interact with and express the 'voice' of citizens and contribute to local environmental related policymaking, being knowledgeable of the on-the-ground issues (Andrews and Shah, 2002; ParlAmericas, 2016; ParlAmericas, 2018). Moreover, GOs are expected to contribute to the dialogue with representation on the regional and international scales. Yet, in many instances today, on-the-ground knowledge does not make its way to national discussions and regional forums, much less international forums. This research uncovers the perspectives of GOs and NGOs— considering each to be local knowledge holders who are experienced with marine debris, and who have professional opinions about how to deal with marine debris. The research further proposes country and sub-region-specific ideas to improve marine debris management, focusing on the core of the problem by addressing the design of new mitigation and adaptation measures

## 2 Methodology

The findings of this research were based on online surveys distributed to policy makers from GOs (i.e., principal departments, agencies and authorities related to fisheries, maritime affairs, water, environment, disaster management, tourism and waste) and NGOs that directly influence and contribute to environmental type or related policies, throughout the five (5) English-Speaking Windward Islands. Government are the primary decision makers in the Caribbean (Hinds, 2019) and NGOs are becoming increasingly influential in Caribbean society (Mohammed, 2021). This extends to their role in policy negotiations, development and decision-making (World Bank, 1996; Bordelais, 2007; Takahashi et al., 2015). Participants were primarily based of customary lists of representatives<sup>3</sup> involved in environmental-related, waste, and ocean-based forums and workshops in the region that eventually lead to project development or policy drafts. Typically, GOs and NGOs interact and coordinate with other relevant stakeholder groups including ocean users, dive shops, hoteliers, academic institutions, and smaller community groups. Hence, the research focuses on these two major groups and a list of twenty-five (25) potential participants was drafted to include representation from each Windward Island state. A snowball technique (otherwise known as a chain-referral) was also applied which led to a total of thirty-five (35) requests for participation in the online survey

The surveys (see [Supplementary information](#)) aimed to capture both existing on-the-ground responses to marine debris or lack thereof and the perspectives of national policy makers and key policy influencers on priorities and relevant solutions for the prevention, reduction and mitigation of the marine debris problem in the context of their country. The survey was composed of four sections including general information about the participants' current position, current marine litter issues and management inefficiencies, actions needed to prevent or reduce marine litter and its impact and management activities indicators for implementation and monitoring (Figure 1). The survey was published on an online platform called Formsite.

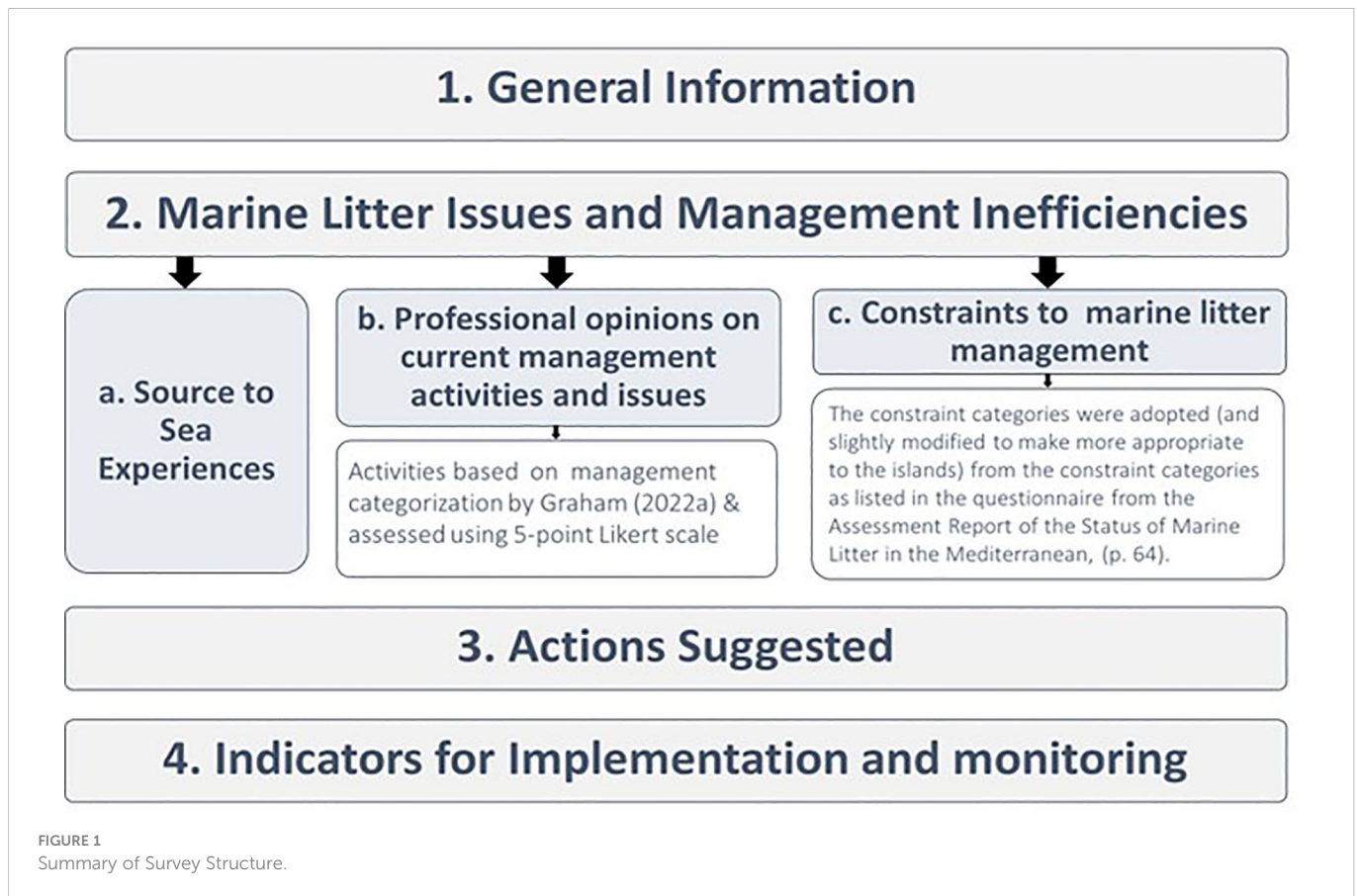
The surveys were conducted between 21<sup>st</sup> February and 21<sup>st</sup> April, 2022. In total twenty-one (21) of the thirty-five (35) participants contacted completed the survey, yielding a response rate of 60%. A summary of each response was anonymized and stored on a secured drive.

A major reason why the response rate was not higher is likely due to the fact that one representative tends to hold multiple roles and responsibilities within and external to their job. This is not unusual and represents a commonality in SIDS of WCR whereby a small pool of people is represented in policy related planning, drafting, and institutionalizing. On a lesser scale, another reason was refusal to participate due to lack of time during the period of study. The anonymized list of participants and the department or organization they represent is presented in the [Supplementary material](#). The

1 Prepared by [United Nations Environment Programme \(UNEP\), 2014](#).

2 Prepared by [Ali et al. \(2021\)](#).

3 Accessed from the Government of each Windward Island, as well as through Plastic Waste Free Islands (PWFI) and the Caribbean Marine Protected Area Management (CaMPAM) Network and Forum.



participants are characterized in Section 3.1. The resultant data from the survey on Formsite was imported into Microsoft Excel Software to facilitate data analysis. It is important to note that the analysis uses the compilation of perceptions and opinions of participants to inform policymaking and management responses and is not an analysis of participants' actual answers.

## 3 Results

The findings are structured into three sections including participants characterization, perspectives on current marine litter issues and management inefficiencies, and perspectives on actions needed to prevent and reduce marine litter.

### 3.1 Participants characterization

Each English-speaking Windward Island was represented in this study. The majority of participants were from Grenada (52%) followed by St. Lucia (24%) (Figure 2). SVG had the lowest response rate, however forums and online databases with current issues and activities relevant to marine litter for The Grenadines were referred. Sixty-seven (67%) of the total participants are associated with Government departments, divisions and agencies and the remaining 33% were from NGOs (including global to local non-profit representations) (Figure 3).

### 3.2 Perspectives on current marine litter issues and management inefficiencies

#### 3.2.1 Marine litter- source to sea experiences

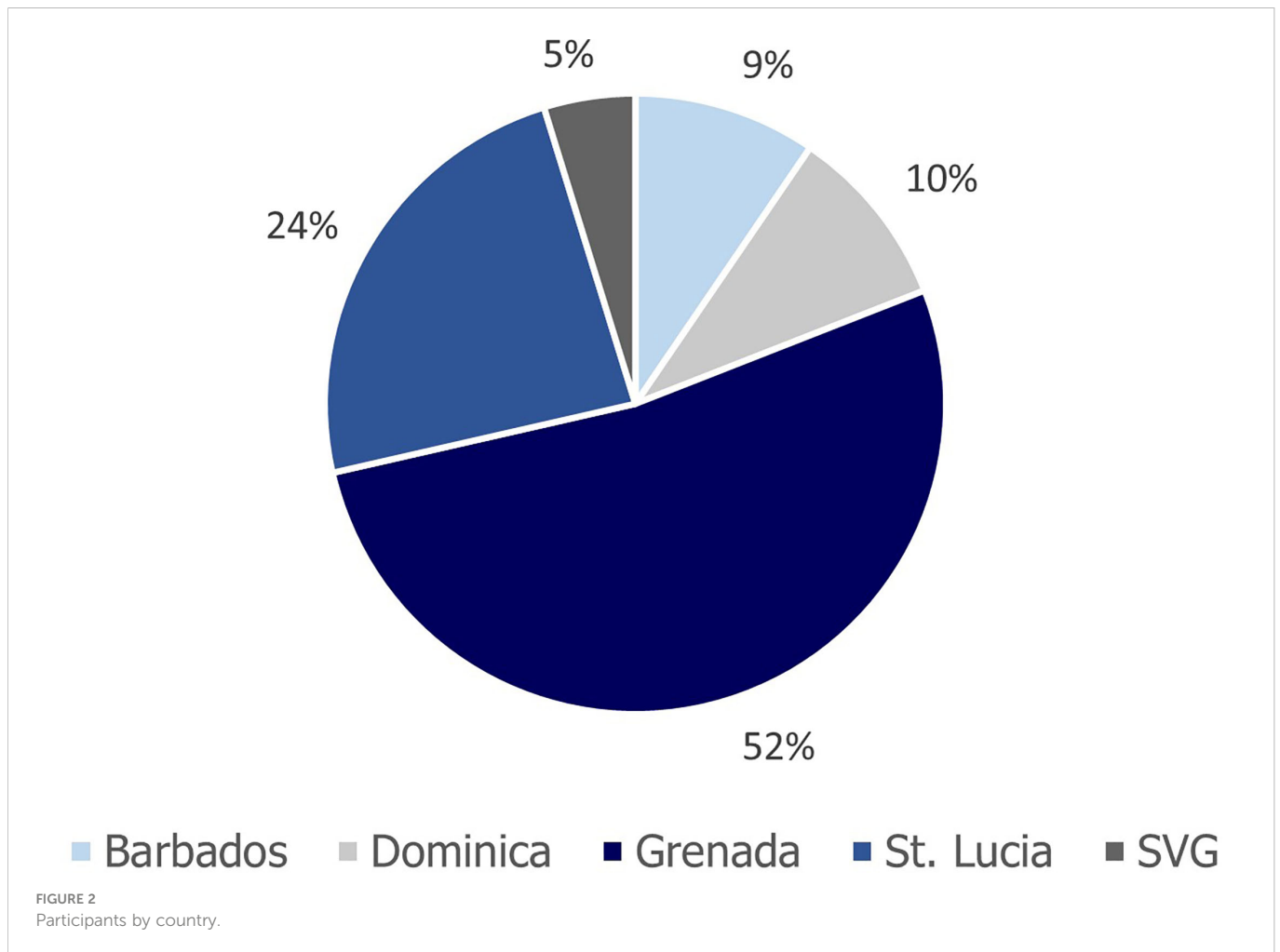
The concept of source to sea experiences used, is much like *ridge to reef* and essentially consists of participants' observations and knowledge regarding strong connections between what happens on land, along waterways, coastal zones and in the territorial marine environment (12 nautical miles) contributing to marine litter. The source to sea experiences were divided into two categories including land to sea observations and ocean-related observations. Illustrates a combination of the participants' experiences and observations (Figure 4).

Summary of Frequently Observed Marine Litter Issues [Artwork]. Author.

#### 3.2.2 Participants views about effectiveness of current marine litter management

The 5-point Likert scale adopted from Allen and Seaman (2007), transitions from 'extremely' to 'very' effective, which can generally serve as an indication that the management activity is effective; to moderately or slightly effective, which can indicate that the management activity is not quite to almost effective; to not at all effective. In all management activities, the greater proportions of responses lie between not quite to almost effective (Figure 5). This indicates that the greater majority of participants are of the belief that improvements can be made for effectiveness across all activities.





It is important to note that none of the participants was of the opinion that legislation and enforcement, preventive measures, removal and monitoring are extremely effective. Further, monitoring received the lowest effectiveness score overall. One third of (1/3) the participants' professional opinion is that current monitoring strategies and activities are not at all effective, and the remaining two thirds (2/3) are of the opinion that monitoring measures (if they exist) are not quite effective and reporting is lacking. All of the participants agree (with 67% of the participants strongly agreeing) that monitoring can go beyond just monitoring of debris removal, but monitoring of the other management activities (e.g., effectiveness in prevention measures, legislation, progress in research and information management) for providing updated quality status reports, supporting a recommendation coming out from a review by [Graham \(2022a\)](#). Another noteworthy result is that all of the participants claimed that current education and outreach measures have some level of effectiveness, the greater majority indicating that such measures have been moderately effective.

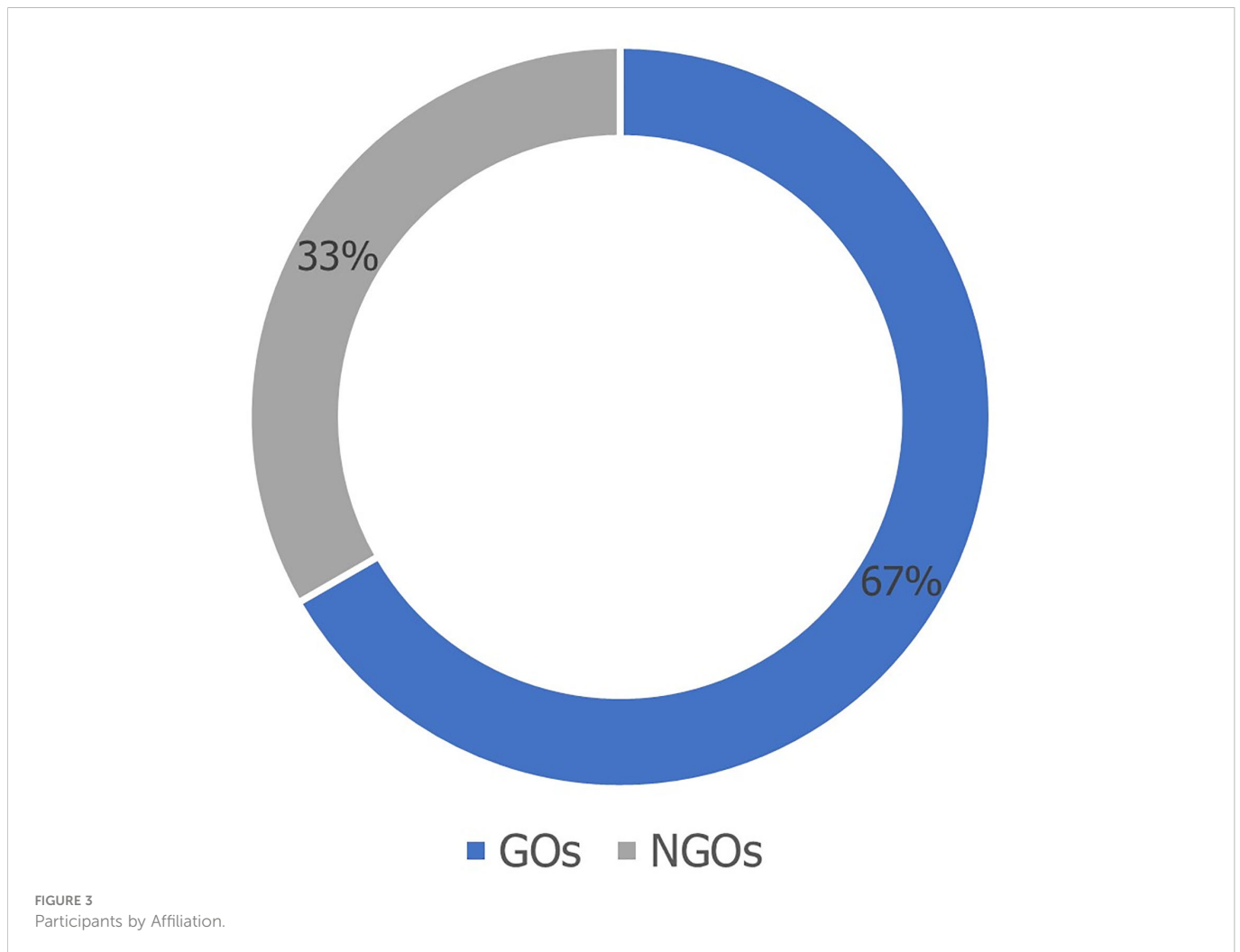
### 3.2.3 Participants' views on constraints to marine litter handling

In terms of administrative and legal matters, a greater majority of participants (67%) are of the opinion that the lack of marine litter policies is the major constraint that prohibits sound coastal and marine litter handling. This is a given since the islands do not yet have

their individual national marine debris policy ([Figure 6](#)). This is followed by inadequacies of laws and regulations as well as associated enforcement and compliance mechanisms (57%), which participants also included in the 'Other' choice option. Thirty-three percent (33%) of participants chose standards issues as a top three constraint and agreed that it is impossible to have a common synthesis of data collected due to the fact that each debris removal and count initiatives within and across islands are conducted with different standards. This included differing data cards used, and measurements taken (number of items versus weight of debris versus both), while certain pertinent information could be missing (e.g. length and type of coast cleaned and the proximity of coast to sources of litter).

As it pertains to constraints to achieving technology and infrastructure requirements, most participants (67%) selected the lack of or inefficiencies of treatment plants. This is regarding both solid waste<sup>4</sup> and wastewater including sewage and storm ([Figure 7](#)). Large-scale solid waste treatment facilities are uncommon in developing countries ([Perkoulidis et al., 2011](#); [Ziraba et al., 2016](#); [Khan et al., 2022](#)), including WCR's ([Grau et al., 2015](#)). With regards

<sup>4</sup> Specifically in the islands' context, there's a need for facilities to carry out effective and consistent solid waste segregation, as well as techniques to change the character or composition of solid waste to have minimal impact on natural environments.



to wastewater, unfortunately, 85% of untreated wastewater is discharged into seas, rivers, and bays in the Caribbean (United Nations Environment Programme (UNEP), 2015; Streets, 2016). Some islands e.g., Grenada and St. Lucia, treat and filter wastewater before it enters the rivers, but do not treat the wastewater that goes directly into the ocean. Participants are of the belief that the overall lack of wastewater treatment allows pounds of debris to enter the marine environment.

Further, almost half of the participants believe that inefficiencies of reception facilities and lack of compaction (technology and activity) can be considered major constraints to sound coastal and marine litter handling as well. Infrequent compaction tends to result in overwhelmed open-air landfills which can consequently lead to debris easily entering waterways and the sea. Few studies have shown that debris from solid waste dump sites (both legal but mismanaged and illegal) on and near coastlines eventually enters the sea *via* the influence of winds (Galgani et al., 2010; Hammer et al., 2012; Beeharry et al., 2017).

Eighty-six percent (86%) of the participants agree that the major constraint that prohibits sound waste management and coastal and marine litter handling, in terms of support services, is monitoring and policing (i.e. enforcement and compliance) measures (Figure 8). Inefficiencies in public information and educational outreach is also identified as a main constraint (52%).

### 3.3 Perspectives on actions needed to prevent and reduce marine litter

#### 3.3.1 Setting national priorities

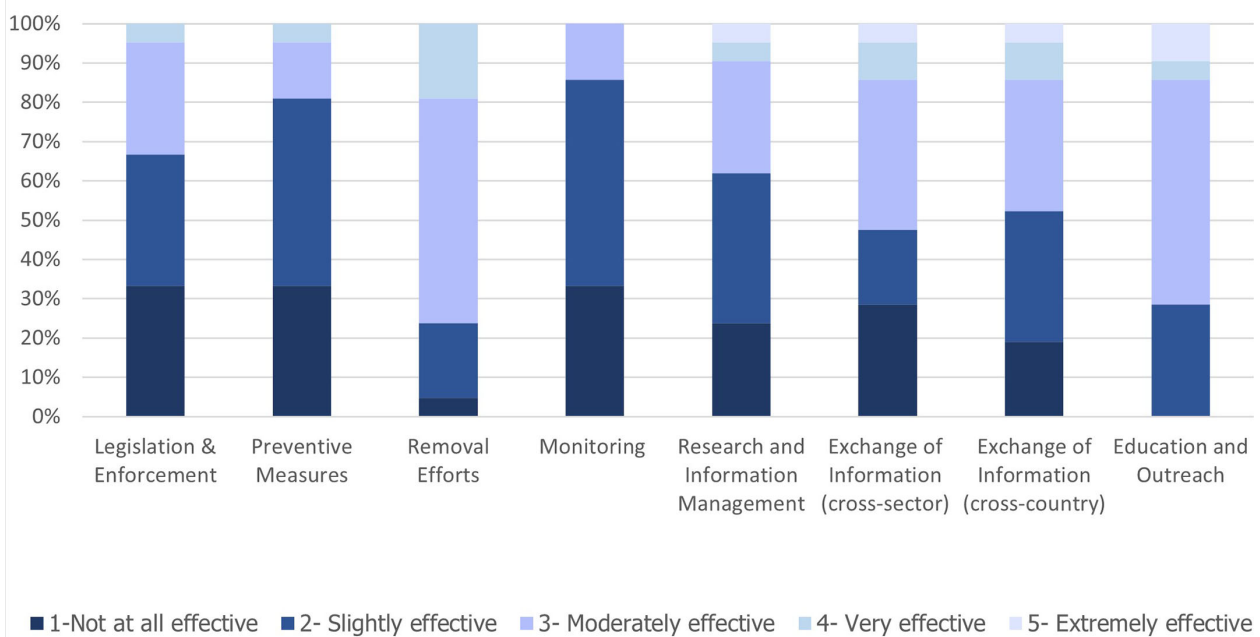
Participants were asked what the top three (3) national priorities should be for enabling on-the-ground actions for better coastal and marine litter prevention and reduction. Establishing feasible recycling systems (i.e., from collection, processing, remanufacturing and or exportation) was the top choice for 95% of the participants. This is a major research finding with respect to designing mitigation measures. This was followed by changing social behaviors (67%) (which includes a combination of product and consumer literacy, improving disposal habits and compliance with laws and regulations) (Figure 9). The third priority included education and public awareness which in itself can feed into the other priorities. It is important to note that annual funds allocation for removal efforts closely followed suit.

#### 3.3.2 Proposed actions to prevent and reduce marine litter

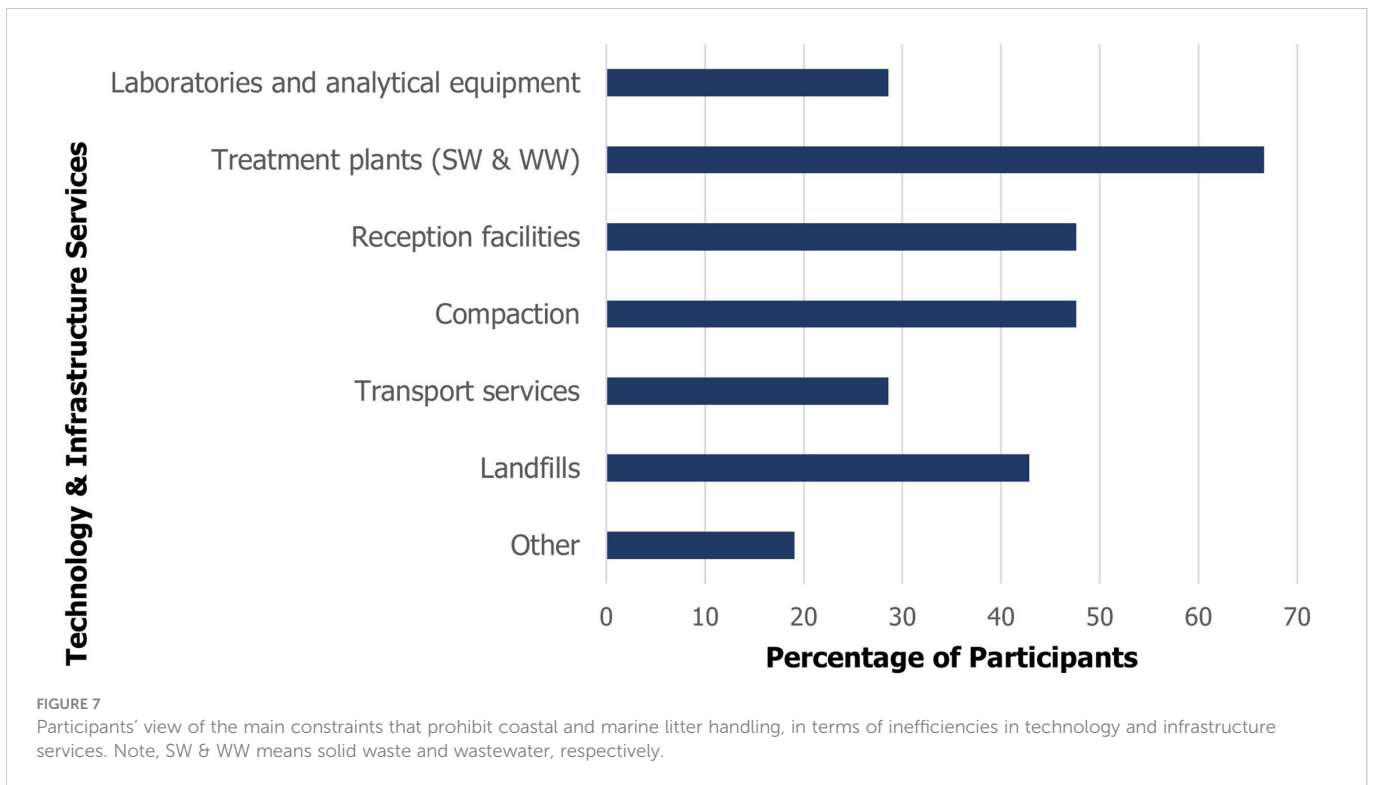
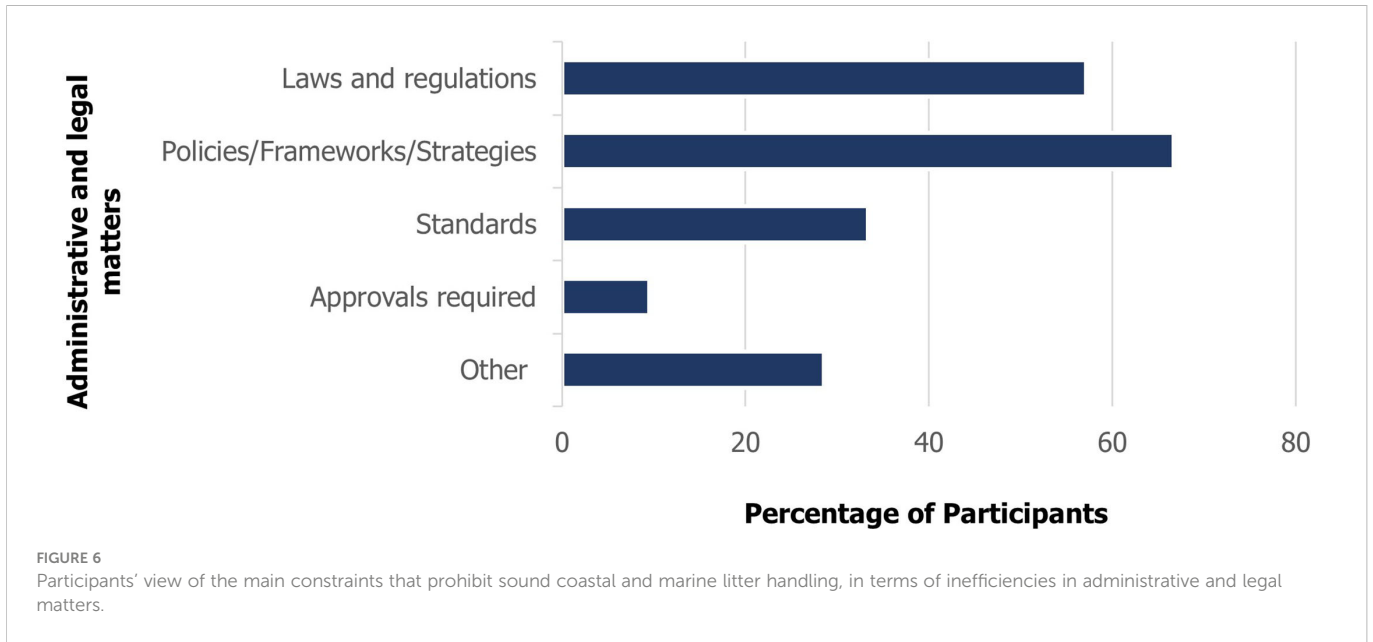
The proposed actions listed in Figure 10 are the perspectives of the participants from an open answer question on how to deal with marine litter issues and management constraints. Thus, it may not necessarily address every issue surrounding marine litter. Additional recommendations were posed in the Discussion section.



**FIGURE 4**  
 An illustration of marine litter issues based on the observations shared by participants (for country-specific details refer to supplementary information). Some of the land to sea experiences are linked to solid waste management issues, including 1. illegal dumping on or near coast and rivers, and 2. overwhelmed trash cans (also tied to insufficient trash cans and inadequate collection efforts) resulting in inappropriate disposal of trash by the public, and the encouragement of stray and wild animals to 'rummage' and spread trash. Usually, overfilled trash cans can be observed near drainage systems. 3. The haphazard use of old tires (among other debris) to serve as coastal barriers because of sea level rise and consequent erosions and flooding. 4. Inappropriate disposal of engine oil bottles by fishermen. Ocean based experiences included 5. Debris entrapped in *Sargassum*, whether the debris is transboundary or from the mainland or both, remains to be investigated. 6. Illegal dumping and discharges by ships.



**FIGURE 5**  
 Professional opinions on effectiveness of marine litter management activities in the Windward Islands.



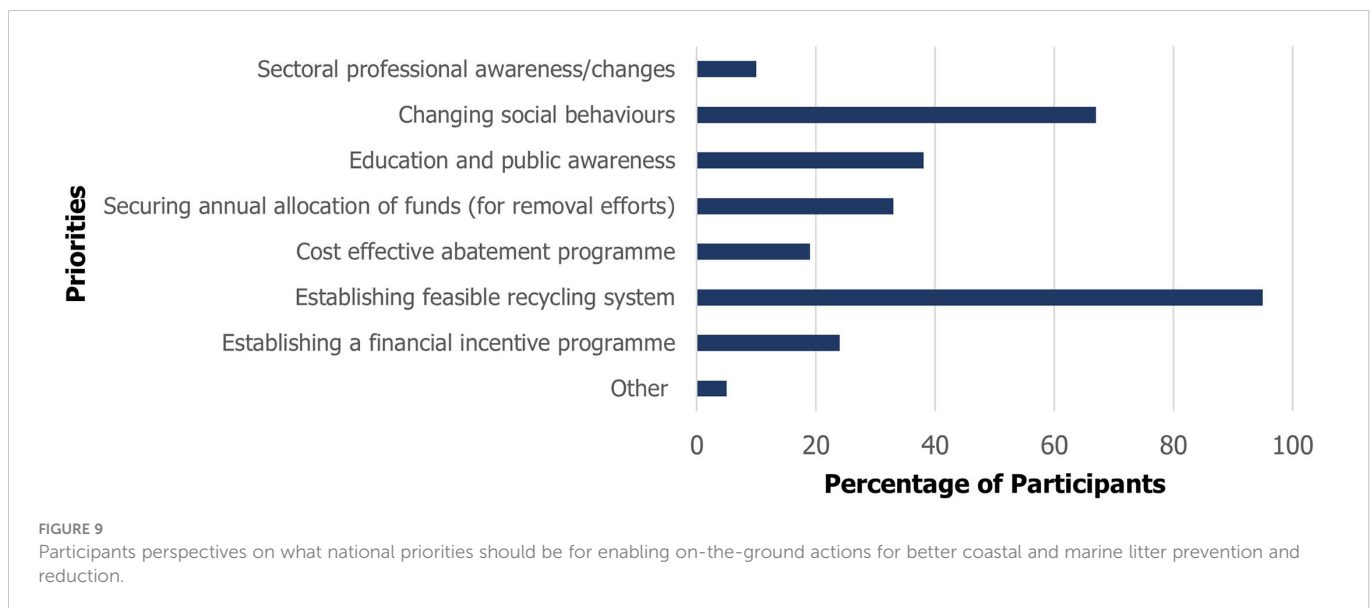
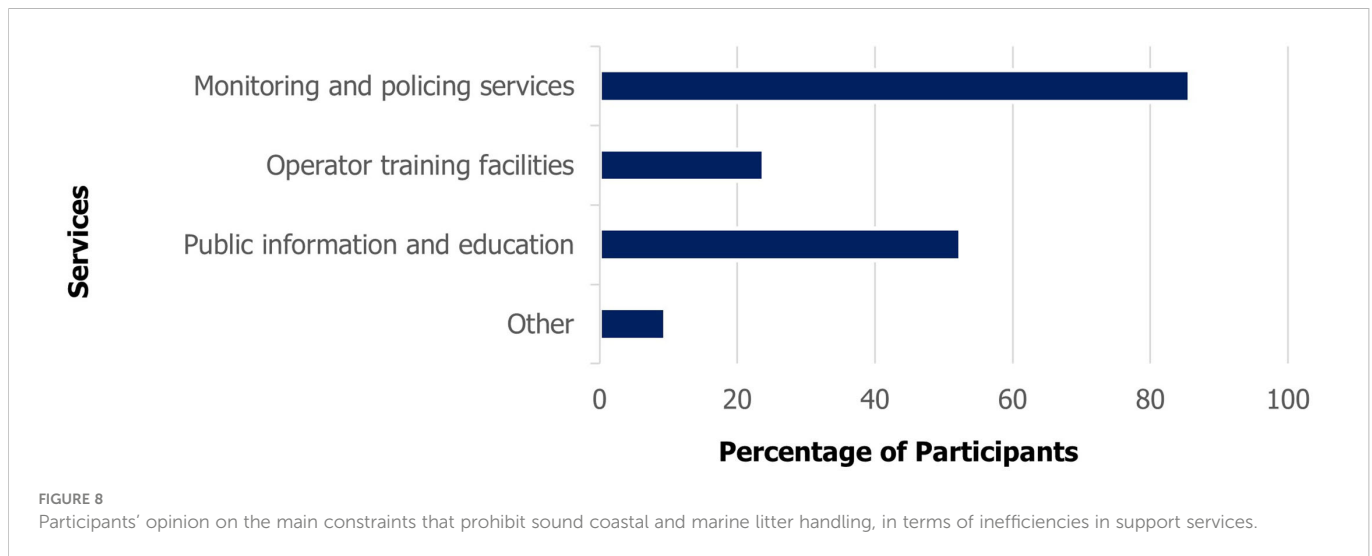
Lastly it is important to note that even with the recommendations and developing a policy in future, there needs to be monitoring and not just of the waste or marine litter reduction progress. All participants agreed that the management activities framework proposed by [Graham \(2022a\)](#) with added indicators ([Figure 11](#)) is an ideal guideline for drafting, monitoring and evaluating future policy related to marine litter management. One suggestion was made regarding placing responsible agents in the diagram, however perhaps this can be left to the country specific level. Also, establishing common sub-indicators (e.g., standardization in removal counts) was recommended.

## 4 Discussion

### 4.1 Deciphering perceptions and joining the dots

The participants' land to sea experiences with marine litter reveal that most of the sources of marine litter are largely linked with inefficiencies in SWM infrastructure and systems. This finding confirms those of a recent literature review on the Windward Islands conducted by [Graham \(2022b\)](#). These findings also reflect the results of similar studies done in the Caribbean ([Clayton et al.,](#)





2021; Diez et al., 2019; Brooks et al., 2020), other SIDS e.g. Cape Verde (Ferreira et al., 2021), and even islands of developed regions e.g., the Greek islands (Skanavis and Kounani, 2016; Kounani and Skanavis, 2018). These inefficiencies include insufficient trash bins for public usage, inadequacies in disposal and collection schemes especially for household “white goods”<sup>5</sup> and bulky waste, the lack of waste segregation, overfilled trash sites and landfills, and lack of recycling opportunities. There are three major stemming observations from

<sup>5</sup> Large home appliances such as stove, refrigerators, freezers, washing machines and air-conditioners.

<sup>6</sup> Exception because, there are no large rivers in the relatively flat island of Barbados which is reason for the island's low hydropower potential (Perez Sanchez, 2019). Moreover, “although there is substantial rainfall, most of the rivers are dry due to the permeable nature of the karstic (limestone) soil which limits surface water” (Global Environment Facility-Integrating Watershed and Coastal Area Management Project, 2019).

participants. One, several drainage systems, culverts, waterways such as ravines, tributaries and rivers especially in or near cities (which are mostly coastal), contain various litter items (largely plastics) on a daily basis. These active rivers and watersheds (which there are many [See Appendix A], with the exception of Barbados<sup>6</sup>), eventually connects to the sea, and thus significantly contributes to marine litter. This supports the conclusions of other recent studies (such as González-Fernández et al., 2021 and Meijer et al., 2021), which claims that the majority of marine litter (over 80%) are riverine litter, which is to say that it comes from the terrestrial environment. So, how does trash get there in the first place? Perhaps, the second and third observations by participants can shed light on the answer to this vital question.

The second observation made from participants (specifically from Dominica, Grenada and St. Lucia) are overfilled curbside and communal bins (or the result of insufficient bins or not emptying these bins regularly enough). These curbside and communal bins are also commonly near drainage systems. Trash can easily blow out of overfilled bins. Additionally, if bins are filled, people have a tendency

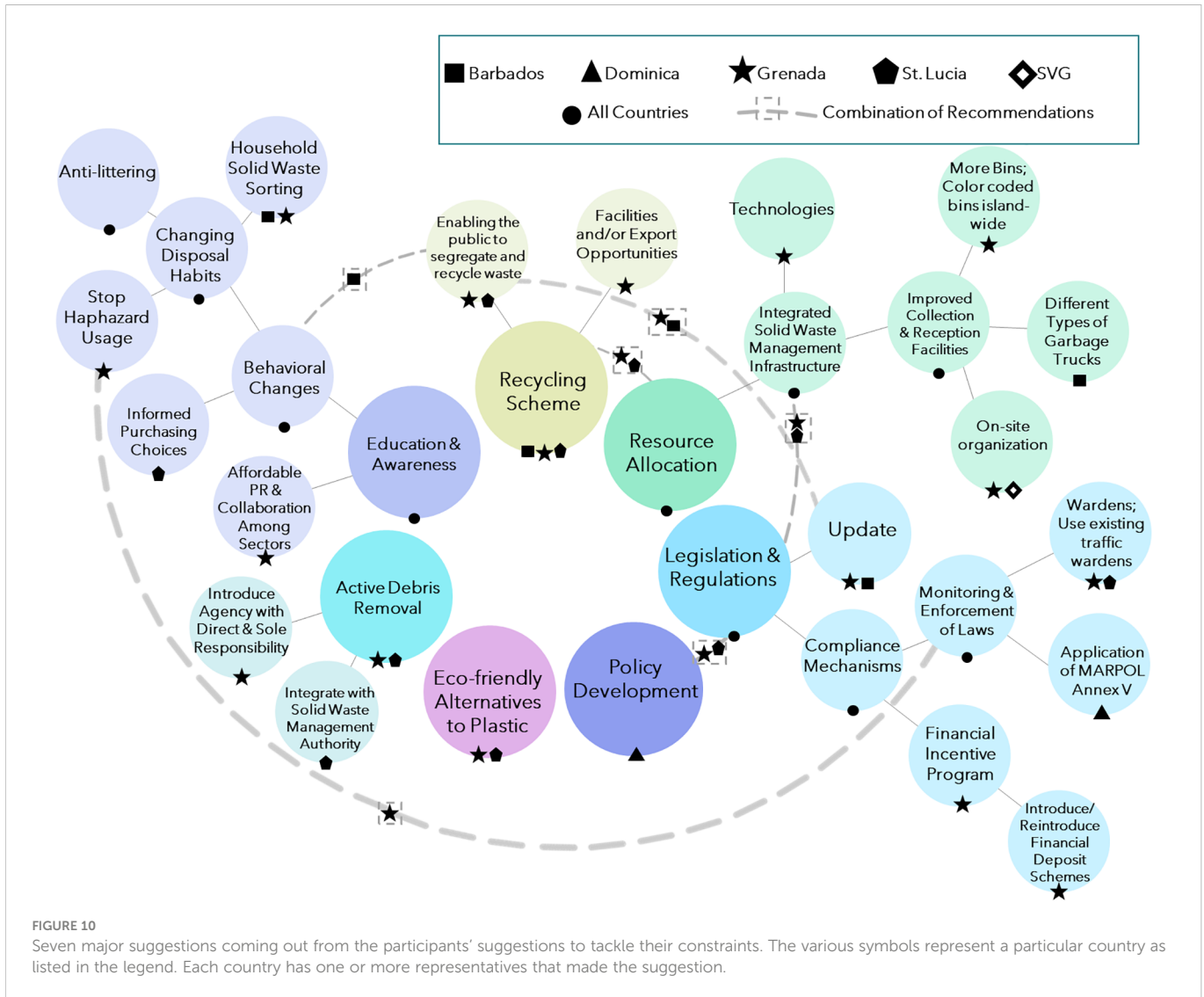


FIGURE 10 Seven major suggestions coming out from the participants' suggestions to tackle their constraints. The various symbols represent a particular country as listed in the legend. Each country has one or more representatives that made the suggestion.

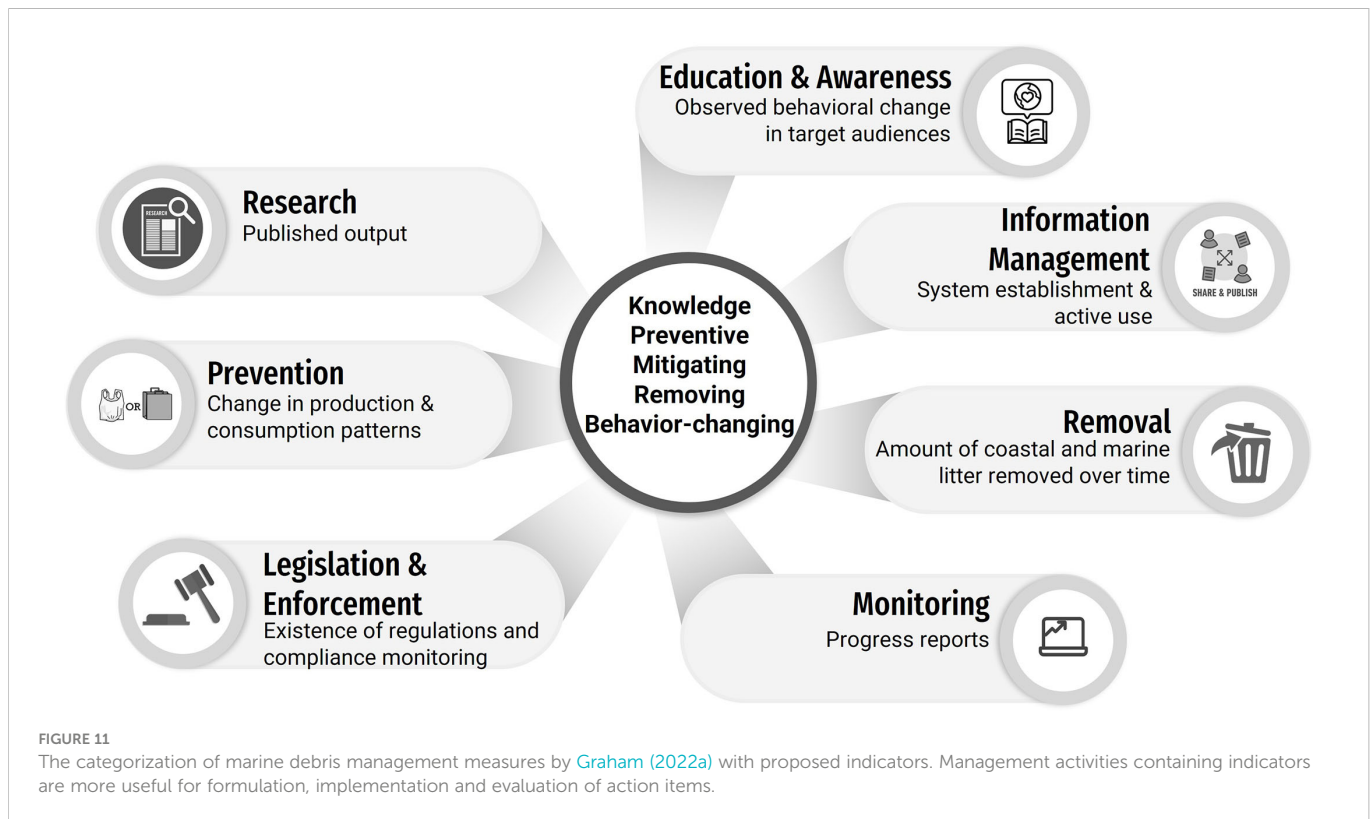
to dispose of their rubbish next to it. Participants from St. Lucia and Carriacou (sister-isle of Grenada) expressed the dilemma faced with stray and wild animals that tend to frequently “rummage” and spread trash piles. Several studies in Caribbean countries have indicated that stray animals, especially dogs, have a common presence in communities and are often responsible for scattered trash (Fielding and Ostberg, 2008; Johnson et al., 2016; Trotman, 2018). Perhaps, the countries need to consider a sterilization of stray dogs program (like that of Curaçao) (Curaçao Tourist Board, 2021) to combat growing strays population. Alternatively, if garbage collection is done more consistently or more often in certain countries' cases, strays will not have a chance to scatter it. Additionally, countries can install technology such as stormwater litter traps to stop the flow of debris from land to drains, or floating litter traps and barriers which help to capture litter along waterways. Studies have shown increasing success in such devices preventing average amounts of debris entering the coastal and marine environment (Whitehead et al., 2010; Schlining et al., 2013; Willis et al., 2017; Sugianto et al., 2022).

The third observation linked to SWM issues are illegal dump sites (otherwise known as open dumps), which are lying adjacent to waterways or near coasts and oceans. According to participants from Grenada this is particularly evident on their island. St. Lucia

has also seen increased concerns of illegal dumping, many of which are in or near the coastal zone (St. Lucia Solid Waste Management Authority, 2021).

Hence, it is reasonable why participants have proposed integrated solid waste management (ISWM) infrastructure as a major requirement and solution to the marine litter issue in their individual countries. In the context of the Windward Islands, an appropriate collective meaning of ISWM may be a way in which solid waste is sustainably managed and addresses several factors more effectively. These factors include generation, but more importantly (because the islands largely import and not produce disposable products) segregation, disposal, collection, removal, transfer, sorting and treatment, in tandem with recycling. This version of ISWM will begin the journey of maximization of resource use efficiency and minimization generated solid waste. This should ultimately ease the amount of garbage that enters both the terrestrial and marine environments.

Although the ideal strategy is to prevent or minimize solid waste from entering any system, relevant authorities also need to be mindful and address the debris associated with wastewater. Enhancing filtration in wastewater systems is perhaps an ideal start. The ideal prototype and process for wastewater treatment contains filter (and in



some cases prefilters) to limit the amount of macroplastics and other debris from entering the aquatic environments, and further separated for proper disposal (National Oceanic and Atmospheric Administration (NOAA), 2017; Gkanasos et al., 2021). There are even modern plants capturing up to 99% of microplastics too (Carr et al., 2016; National Oceanic and Atmospheric Administration (NOAA), 2017; Habib et al., 2020; Tang and Hadibarata, 2021). Tang and Hadibarata (2021), reviewed wastewater treatment technologies for microplastics removal of the last decade and found that advanced treatment (particularly secondary and tertiary filtration) is best for the efficient removal of microplastics, along with the potential use of emerging sol-gel technology. This technology allows for contaminant removal through agglomeration, and in the case of microplastics it forms microplastic flocculates, which removal can be completed through separation mechanisms such as sand traps (Collivignarelli et al., 2017; Tang and Hadibarata, 2021). Essentially, it is a similar process of treating freshwater for consumption in many countries (both developing and developed) via the “Slow Sand Filtration Treatment” process<sup>7</sup> (Elliott et al., 2008; Hassard et al., 2022).

Despite the need for ISWM, it has been a struggle for these island nations to invest into the necessary infrastructure and capacity to support it. Possible reasons include one, marine litter and waste management are lower on the list of national priorities<sup>8</sup>; two, debris removal as a component by itself is expensive for the islands and they depend on donations from NGOs and private sectors (National Oceanic and Atmospheric Administration (NOAA), 2020; Graham, 2022a), thus, a grander ISWM scheme would require far greater expenditures. These reasons mainly stem from the fact that as the generation of solid waste continues to increase, so does the burden posed on the national budget, given the high costs associated with its

management. According to Diez et al. (2019), in the context of WCR, the amount of litter collected per year is affected by budget limitations. Perhaps, there exists a perception that solid waste management is not profitable.

The litter problem has been and continues to be mainly dealt with at the end of a product’s cycle (i.e., consumption and disposal), thereby leaving the entire responsibility of litter issues on consumers (Graham, 2022a). This approach is far from optimal because consumption and disposal is a significant part of an extensive and profitable chain (Organisation for Economic Co-operation and Development (OECD), 2021; Graham, 2022a). Moreover, there is a lack of empirical studies that investigate the profitability of adopting circular economy concepts for waste processing largely due to inaccessible market data (Zaleski and Chawla, 2020).

Another challenge identified in the small island dynamic is how to hold the producers of plastics responsible in the context of preventing marine debris. Many of the producers exist in developed countries, in other words: outside of the regions to which they export. Something to consider is that producer responsibility is increasing worldwide

<sup>7</sup> In Grenada, this involves collecting and transporting surface water from the dams in the rivers to the treatment plant at which point, coagulation, flocculation, sedimentation and filtration occurs (National Water and Sewerage Authority (NAWASA) Grenada, n.d.). This is followed by chlorination of the filtered water.

<sup>8</sup> National priorities include addressing extreme poverty, better healthcare, reducing inequality, promoting economic growth and developing sustainable cities, while considering climate change, governability and population growth pressure (United Nations Economic Commission for Latin America and the Caribbean, 2018; Salvia et al., 2019; Mahlknecht et al., 2020).

(Dalhammar et al., 2021; Yi et al., 2021; Joltreau, 2022). Most islands are highly dependent on imported food and manufactured goods locally consumed and used (Potter, 2002; Eckelman and Chertow, 2009; Clayton et al., 2021) and so are the Windward Islands (Graham, 2022a). As it is known, most of the food consumed comes in packages, especially plastic ones, as they are durable, maintain food quality and are also more convenient in terms of transportation and usage by consumers (Ferreira et al., 2021), contributing to the increasing global production of plastic. Global plastics production doubled from 2000 to 2019 to reach 460 million tonnes (Cooke, 2022; Organisation for Economic Co-operation and Development (OECD), 2022a). Recent research shows that in Barbados, Grenada, St. Lucia and SVG, plastic bottles and plastic packages of food and other domestic products are the main type of marine debris collected. For Dominica it is the second most dominant type as redundant fishing gear is the main type of litter in the marine and coastal environment. Nowadays, according to Graham (2022a), while global industries focus on alternatives to replace the conventional package material especially plastics, the same alternatives (e.g., recyclable plastics) will continue to gather in open air landfills of the Windward Islands. The question now becomes can oversea producer responsibility extend to SIDS and how profitable or non-profitable such a venture may be? According to Dauvergne (2018), international trade obscures responsibility.

While identifying the chain of responsibilities to prevent marine litter is important, there is a practical policy recommendation to hold the retailer accountable under their environmental obligations. For example, empty engine oil bottles can be found in abundance in various non-touristic shores and bays across the island of Grenada. Often, these shores lack garbage bins. Thus, these empty engine oil bottles are left behind on the coast after fishermen fill their boat's engine before proceeding for their daily fishing activities. One survey participant expressed that this can be avoided if strong financial incentive programs were in place. The participant is alluding to deposit-refund schemes. Such a program is the environmental responsibility of businesses and companies to ensure that waste is disposed of appropriately. Deposit-refund schemes have shown to increase the rate of solid waste recovery and recycling rates (once recycling schemes are in place) (Linderhof et al., 2019; Oke et al., 2020; Schneider et al., 2021). Thus, monetary deposits placed on retail price of engine oil bottles can encourage return and significantly reduce the amount of empty engine oil bottles found littering the coastline and bays. This measure also works well in the absence of strong anti-litter law enforcement.

As it pertains to the issues associated with natural phenomenon, marine debris management becomes more complex and less controllable. Graham (2022a) previously identified the risks associated with natural disasters such as storms and hurricanes and *Sargassum* influxes and how they contribute to marine debris in the region. Participants confirmed the linkages between these two types of natural events and the accelerating problem of marine debris in the region. Along with the climate change effect of sea level rise, the influences of these have all been observed in the context of marine debris. Coincidentally, the examples provided by the participants were based in the remote Grenadine Islands. The Grenadine Islands are crucial to consider because they are even more remote, and they are dependent territories. This dynamic consequently deprives the islands of opportunities for independent socio-economic growth and

more importantly forces them to rely on policy support from their appropriate mainland.

Both the natural events and associated responses to sea level rise and consequent frequent flooding and coastal erosion could contribute to the increase of marine debris. In the island of Carriacou (which is also classified as a Grenadine Island), debris is haphazardly used to create coastal defenses, as the thirteen (13) square miles of island is increasingly being inundated by the ocean. In desperation the inhabitants and users of various coastal zones use debris material to construct makeshift barricades to prevent or ease flooding and erosion. Among the natural debris such as rocks, coral rubble and wood debris, there are more problematic debris types used including primarily used tires<sup>9</sup> and construction and demolition waste of various types<sup>10</sup>. Coastal flooding and erosion are also evident in Grenada and makeshift breakwaters and barricades can also be found there (The Nature Conservancy (TNC), 2018). Such human induced climate change related impacts and how they contribute to marine debris are absent in the most recent 2021 Strategic Plan for Marine Litter Management in the Wider Caribbean Region Caribbean Node for Marine Litter.

Regarding *Sargassum*, generally various types of trash, especially plastics, are often observed in its accumulation floating offshore (Laffoley et al., 2011) as well as on shorelines (Hinds et al., 2016; Schiariti, 2021). One example provided was the Grenadine Island of Bequia. Cleanup activities in 2022, in beaches across Bequia would reveal several debris items (e.g., fishing ropes and nets, plastic bottles, flip flops, toothbrushes, bottle caps and microplastics), which were recorded by Action Bequia. Some debris were found entrapped in *Sargassum* and others found further in coastal locations. Moreover, locals in the islands of Bequia speculated that some of the debris are transboundary, likely coming from the North Atlantic Ocean Gyre and prevailing currents. Whether the debris is from other regions, other countries, neighboring shores in Bequia or within the same coastal zone, the *Sargassum* and entrapped debris are described as unsightly. *Sargassum* is known to affect the image of many Caribbean islands' shores (Scruggs, 2015; Watson et al., 2019) and limit and restrict ocean access (Hinds et al., 2016; Thompson, 2021). Debris entrapped in *Sargassum* has also been known to pose health risks in the Caribbean. Hinds et al. (2016), stated among the debris collected on islands, hazardous medical wastes are included. Bequia has attempted the use of booms (proposed seaweed barrier solution) to help prevent floating debris from entering its shores, however this strategy was ineffective (Japan International Cooperation Agency, 2019). Booms are also known to prevent transboundary floating

<sup>9</sup> Used tires can be effective defense for rising tides, sea levels and minimizing flooding and erosion (Karlsson and Hovelsrud, 2015; Rangel-Buitrago et al., 2018) however the haphazard use can lead to several bio-physio impacts on the marine environment including the release of tiny plastic polymer and destruction of sea grasses and corals (bio-physio impacts). They've also served as breeding grounds for mosquitoes, such as *Aedes aegypti* that can transmit dengue fever (Raffoul et al., 2006).

<sup>10</sup> Potentially harmful ones to the environment and health including but not limited to heavy metals, glass and specific to demolition of old buildings-asbestos.



debris, however in this case it also was not useful in collecting potential transboundary data.

An additional ocean-based observation and concern coming out from the surveys included the illegal dumping of waste by cruise ships, cargo, fishing vessels and pleasure crafts e.g., yachts. Given the islands' sensitive and fragile marine ecosystems (Allen, 1992; Fanning et al., 2011; González-De Zayas et al., 2020) and the heavy maritime traffic (Heenehan et al., 2019) this is a cause for concern. In 1991, The Windward Islands and the Caribbean at large were designated a Special Area with restrictions under MARPOL Annex V in 1991. The Windward Islands (with the exception of Grenada<sup>11</sup>) ratified MARPOL Annex V (United Nations Environment Programme (UNEP), 2014; Graham, 2022a; Graham, 2022b). According to Regulation 6, ships entering the WCR are expected to offload their inorganic solid waste in their ports or onshore reception facilities, and organics (food waste- comminuted or ground) 12 nm or more from land. The problem continues to be that the volume of debris and litter that was once dumped into the sea now must be processed at ports (Association of the Caribbean States, 2012). Moreover, recent research indicates that ports in the region still lack the infrastructure or reception facilities necessary to support the increases (Jordan and Vogt, 2017). According to Association of the Caribbean States, 2012, given the increases in maritime traffic over the last decade, the region's ports are currently at risk of becoming overburdened, although it has been reported that the majority of ports in the region have adequate port reception facilities.

## 4.2 The way forward

This research recommends using the localized knowledge and suggestions for incorporation into future policymaking. It also recommends a slight adjustment in focus.

### 4.2.1 Using the localized knowledge

The participants had the opportunity to critique current management of marine litter and propose solutions as captured in Figure 10. The three main solutions coming from all the Windward Islands include resource allocation particularly for ISWM and recycling schemes, update of legislation and enforcement (which is linked as a management activity of ISWM) and education and awareness. Resource allocation to SWM has been challenging for the islands for the last two decades. According to Graham, 2022a and Graham (2022b) a proper functioning SWM is a pre-requisite for the worldwide transformation to a circular economy particularly in waste management. Circular Economy is a sustainable alternative to the traditional "take-make-waste" linear economic model, reducing waste to a minimum by reusing, recycling and repurposing (Sariatli, 2017;

Manickam and Duraisamy, 2019; World Bank, 2021). However, a host of complex environmental to socio-political factors was identified by Graham (2022b) dating back to 2003 which affected the effective use of already scarce funding opportunities (i.e., grants and loans) meant for the investment in solid waste management policy drafting, infrastructure construction and operations.

To date, the islands remain in policy drafting stage, some transitioning from SWM policy to developing ISWM policy and projects, including Grenada (Government of Grenada, 2022) and Barbados (Government of Barbados, 2021), with estimations reflected in their national budgets. This potentially speaks *volumes* as to why marine debris policies have not been drafted yet as indicated by Graham (2022a). While policy drafting and revision is important, capacity building and infrastructure investment is even more important to facilitate achieving the objectives of effective SWM and ISWM. One can argue what is the point of SWM policy if you do not have the capacity and infrastructure needed for achieving the basic outcomes of SWM. Noting that solid waste management practices differ for developed and developing nations, there is still one common expectation of effective solid waste management infrastructure and facilities. This expectation is that solid waste is prevented, minimized, and systematically controlled from its generation, disposal, collection, recovery, transport, separation, landfilling, treatment, processing and compaction and ideally recycling (Modak, 2010; Bilitewski et al., 2015; Kurniawan et al., 2021; JICA, n.d.).

The effectiveness of SWM or ISWM would require legislation and regulation compliance (including advocating both local and international laws) (Hasan, 2004; McNicholas and Cotton, 2019) as well as a well-informed public (Hasan, 2004; Calisesi, 2020). In some instances, the two intersect, as humans need to be aware of the legislations and regulations associated with solid waste management and the consequences of failing to comply. There are primary target groups as well as several relevant awareness themes in the small island, community level dynamic. Key target groups of awareness include civil society, children and youth and community based organisations (CBOs) and youth groups (Calisesi, 2020; Schlauffer et al., 2022). These groups have proven to be the core in stimulating behavioral change at the community level in the aim of improved solid waste management (Calisesi, 2020). Private entities should also be added to this list e.g., privately owned solid waste disposal truck owners and the companies that hire them. Additional awareness subjects should include knowledge of localized waste issues and effects and an understanding about waste reduction, reuse, recycling and resource recovery. This needs to be coupled with the enablement of citizens to be part of the solutions (instead of the problem) (Calisesi, 2020; Schlauffer et al., 2022) which requires resource allocation including most especially financial resources.

Enablement is important because overwhelmed trash sites, lack of bins and inadequate collection all lead to inappropriate disposal behaviors. Case in point is illegal dumping, an issue that SWM resource allocation alone cannot solve. Surely a combination of awareness and enablement are critical. A society that is aware of the health risks of illegally dumping material in or near rivers and in coastal regions (i.e., injuries, rat and mosquito infestations and associated diseases, marine pollution) would likely take actions to address it. An example of where enablement is applicable is the case of

<sup>11</sup> Grenada had under-developed port infrastructure at the time other islands were ratified. Grenada now has a new and well-developed cruise ship terminal with reasonable infrastructure to consider ratifying (Graham, 2022b). In the meantime, Grenada follows the requirement of MARPOL Annex V, Regulation 6, in terms of organic waste of ships being dumped at least 12 nautical miles offshore and inorganic waste at onshore facilities (Grenada Ports Authority, 2019).



Grenada where illegal dumping has been increasing over the years (Robinson, 2020; Elgie et al., 2021). Illegal dumping continues to intensify further in Grenada due to the deterioration and destabilization of a main road which the capital of the country and eastern side of the island utilized to access the island's lone landfill (Robinson, 2020; Grenada Solid Waste Management Authority (GSWM), 2020). Several privately owned solid waste disposal trucks are now required to take a longer journey to access the landfill (Grenada Solid Waste Management Authority (GSWM), 2020). On several occasions over the last three years, eyewitnesses have placed heavy-duty trucks offloading waste at illegal dumpsites, many of which are located in coastal environments (Grenada Solid Waste Management Authority (GSWM), 2020). Enablement for the reduction of illegal dumping in this case would be road access *via* reconstruction of that pertinent main road. In the meantime, perhaps piloting an anonymous hotline for reporting illegal dumping or installing surveillance cameras particularly in hotspots may help to deter the act - a solution that has been worthwhile in several SIDS (Sewak et al., 2021).

There is also the problem of dealing with the unaffordability of awareness campaigns from designing to dissemination through space and time. Traditional formats of mass media for educational and awareness campaigns include use of print, outdoor advertising, digital platforms such as local television (TV) channels and radio, PA speakers on mobile vehicles, and in the last decade online display (OD). PA systems and OD particularly *via* social media are communication means generally known to be relatively inexpensive. Moreover, given that audiences in WCR are increasingly engaging with online media in addition to or as an alternative to TV (cite), perhaps practical solutions to consider is the increased use of OD to communicate messages that will encourage behavioral change. Unfortunately, there are disadvantages to OD as it is limited to households with Wi-Fi access, and poorer communities where littering and illegal dumping occurs may not be reached. Hence, another way to cut costs is industry and sectoral collaboration which can help to unify messages and reduce costs *via* sharing of resources and expenses to enable use of a variety of suitable means. Other practical solutions include bolstering communication of pollution threats and solutions in school curricula (Diez et al., 2019). Typically, the topic of pollution and recycling is taught in science related subjects (Ogunkola and Samuel, 2011) and science is often taught in isolation of other subjects like Mathematics (Ramsawak-Jodha and Welsh, 2016). Perhaps this topic can creatively make its way through other subject areas, especially at the secondary school level (e.g., Principles of Business, Geography, Social Studies to name a few).

#### 4.2.2 Adjusting the focus

ISWM and recycling are expected to be advantageous in contributing to the reduction of debris entering the marine environment on a local level. However, ISWM and recycling even in the best-case scenario are limited options that do not deal with the root causes, and in the case of plastics, it is the unsustainable production of single-use plastics. Even in many developed countries with well-managed solid waste systems, there exists an overwhelming volume of plastic waste entering the marine environment (Owens and Conlon, 2021). In actuality, very little recycling is happening worldwide. Globally, only 14% (World Economic Forum Ellen

MacArthur Foundation McKinsey Company, 2016) to 15% (Organisation for Economic Co-operation and Development (OECD), 2022b) of plastic waste is collected for recycling. Moreover, of the 15%, approximately 40% is discarded from the recycling process due to its low quality (Organisation for Economic Co-operation and Development (OECD), 2022b). As a result, plastic recycling rates border 9% (Organisation for Economic Co-operation and Development (OECD), 2022b). Studies have also claimed that most plastic waste sent for recycling is downcycled, and as low as 2% of the plastic waste is recycled in a closed looped fashion (World Economic Forum Ellen MacArthur Foundation McKinsey Company, 2016; Owens and Conlon, 2021).

Developing waste-handling and recycling systems in countries across the globe where poorly managed solid waste exists, is clearly not in itself a long-term remedy with little global reach. Owens and Conlon (2021) suggest that the global focus moving forward must incorporate addressing the core of the problem - upstream producers, or else the symptoms of the marine debris will persist. Years of framing the marine litter problem as one of solid waste management issues has led to solutions that are more waste management oriented (Owens and Conlon, 2021). This analogy may have resulted in developing countries and regions (e.g., south, and southeast Asia) being the focus of attention due to their visible marine debris issues and mismanagement of waste. However, according to Owens and Conlon (2021), "it is the onus of the upstream producers to prevent harm caused by environmental pollutants, not the downstream work of the civic sector and local governments impacted by the pollution," (p.5). Thus, it may be necessary that upstream producer firms and companies be mandated to reduce the negative environmental and societal impacts of their products throughout their life cycle.

The proposed solutions in Figure 10 do not directly address transboundary and disaster related waste. As marine litter persists an important dynamic to also consider is the challenge of strengthening resilience, which is particularly crucial as these islands suffer recurrent extreme weather-related events such as tropical waves, storms and hurricanes. In addition to the circumstances concerning the events listed in Section 4.1, policy makers need to be mindful of the issues plaguing disaster risks management in the region. In summary, the issues include the challenges associated with the unwillingness of islands to share data from environmental and disaster risk management related research (Fanning et al., 2021; Omukuti et al., 2021), and the main agencies with responsibility for natural disasters rarely place emphasis on the topic of marine debris in its plan or assessment documents (Graham, 2022b). It is recommended that the authorities with responsibility for disaster management either include strategies for disaster related debris in future disaster risks assessments or plan or develop a disaster debris strategy.

A modern and appropriate framework that could potentially be useful in developing such a strategy and addressing the various multifactorial socio-economic and environmental issues is that of the Sendai Framework. According to the United Nations, Sendai Framework for Disaster Risk Reduction (SFDRR) 2015 – 2030, the Sendai Framework is the successor instrument to the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. SFDRR was adopted at the Third United Nations World Conference on Disaster Risk Reduction (DRR), held in March 2015 in Sendai, Miyagi, Japan. Sendai could

represent a unique opportunity to have a strategic approach to capacity development to reduce the risks associated with waste management issues, natural events and their contribution to marine debris in the Windward Islands.

Overall, the features of the Sendai Framework are applicable because it aims to shift focus from managing disasters to managing risks, and embrace risks of “small to large scale, frequent and infrequent, sudden and slow-onset events and disasters, caused by natural or man-made hazards” (United Nations International Strategy for Disaster Reduction (UNISDR), 2015). The risks in the Windward Islands’ case are those associated with sea level rise, sargassum influxes and natural disasters and their influence on marine debris. Not forgetting the risks associated with their current waste management infrastructure situation. The third aim addresses the need for multi-sectorial involvement *via* creating the capacities or enabling situations that allow for “a more people-centered, all-hazards and multi-sectorial approach to DRR” (United Nations International Strategy for Disaster Reduction (UNISDR), 2015). Moreover, it is important to acknowledge the usefulness of Sendai Framework Priority 4, which aims to enhance disaster preparedness for effective response, and to “build back better” in recovery, rehabilitation and reconstruction (United Nations International Strategy for Disaster Reduction (UNISDR), 2015).

## 5 Conclusion

Global governance of and responses to marine litter remains highly uneven, with substantial differences across jurisdictions and this is also evident in national policies (or lack thereof in WCR case) (Graham, 2022a), industry conduct and solid waste infrastructure (Dauvergne, 2018; Frantzi et al., 2021). This research reinforces the usefulness of local-level analysis to identify the specific issues and relationships that influence environmental issues such as marine litter. The expectation is that global governance and opportunities will trickle down SIDS more appropriately through a process of policy osmosis and stakeholder engagement. Bottom-up democracy is known to enhance global environment related governance (Maher and Buhmann, 2019; Parks, 2019; Abhayawansa et al., 2021) and reduce wasteful projects (Kagarlitsky, 2009). Thus, learning the local context is important and the perspectives of the policy makers (who are the local knowledge holders in the Windward Islands) offering a voice in scientific research would be useful in devising potential solutions, on all scales. Research has shown that it has been very challenging for science to influence policy and actual change without local knowledge and involvement (Gregory et al., 2007; Nugroho et al., 2018).

This study confirms several causal factors for marine litter within the Windward Islands context as revealed in a recent review by Graham (2022b). Although factors related to inefficient solid waste management have emerged as the dominant reasons for both terrestrial and marine litter issues, findings indicate two (2) unique factors which the literature does not capture and is crucial to consider in future planning. First, are the details such as rate and locations of certain solid waste issues. Examples include the increasing illegal dumping occurrences in waterways and non-touristic coastal zones,

and overwhelmed trash sites’ tendency to be near drainage systems with frequent occurrences of stray and wild animal rummaging and spreading trash. Second, are the findings which indicate that slow-onset natural events such as sargassum influxes and sea level rise (with consequent flooding and erosion) all exacerbate the marine debris problem further.

Questions regarding the efficacy of existing mechanisms to deal with marine litter and solid waste management issues were raised and suggestions made to advocate for increased funding or resources, compliance mechanisms and incentives, and awareness to stimulate changes in consumption and disposal behaviors, to enable lasting changes. While solid waste handling systems may prove effective in minimizing local waste entering the ocean, it is also crucial to address a major source of the marine litter problem—upstream producers, especially as it pertains to plastics. Upstream producers can exercise preventive and innovative measures (particularly for plastics), and producer responsibility must take more precedence in the near future.

The islands are well behind in developing marine litter policies, and thus have a unique opportunity for their experts and policy makers to contribute the updates presented in this report, and more to future policy planning on a local level and updates on the regional and global level. It is also recommended in this report that future marine litter and solid waste initiatives consider climate change relations.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving human participants were reviewed and approved by World Maritime University (WMU)- Research Ethics Committee (REC). The participants provided their written informed consent to participate in this study.

## Author contributions

RG- Conceived and designed the analysis, collected the data, performed the analysis, created artwork, wrote and submitted the manuscript. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2023.1065299/full#supplementary-material>

### APPENDIX A

Watersheds for 4 Windward-Speaking Islands. Image (A) illustrates watersheds of Dominica (Government of the Commonwealth of Dominica, 1994, as cited in Organisation of American States, 2000). Image (B) shows watersheds of Grenada (Government of Grenada, 2009). Image (C) indicates the watersheds of St. Lucia (Government of Saint Lucia, 2001), and the watersheds of St. Vincent and the Grenadines are shown in image (D), a modified map by DLN Consultants (2006).

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